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**ENGINEERING EVALUATION OF A  
FORMERLY UTILIZED MED/AEC SITE**

**SITE A AND PLOT M, PALOS FOREST PRESERVE,  
PALOS PARK, ILLINOIS**



U of C-AUX-USDOE

**ARGONNE NATIONAL LABORATORY, ARGONNE, ILLINOIS**

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Printed in the United States of America  
Available from  
National Technical Information Service  
U. S. Department of Commerce  
5285 Port Royal Road  
Springfield, VA 22161

NTIS price codes  
Printed copy: A05  
Microfiche copy: A01

ARGONNE NATIONAL LABORATORY  
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ENGINEERING EVALUATION

OF A

FORMERLY UTILIZED MED/AEC SITE

SITE A AND PLOT M, PALOS FOREST PRESERVE,

PALOS PARK, ILLINOIS

prepared by  
Engineering Division  
and  
Division of Environmental Impact Studies

September 1979

prepared for  
Office of Remedial Action Programs  
Assistant Secretary for Energy Technology  
U.S. Department of Energy  
Washington, D.C. 20545





## FOREWORD

More than a hundred sites were used by the Manhattan Engineer District (MED), by the U.S. Atomic Energy Commission (AEC) for research facilities, and by the AEC's uranium suppliers and processors during the early years of development of the nuclear program in the United States. Although operations have long ceased at many of these sites, in many instances radioactive substances remain which can be a potential source of exposure to the public. Traces of radioactivity may remain on building and equipment surfaces and in the soil or subsoil. The U.S. Department of Energy is currently active in a program to ensure that the necessary precautions are taken in the management of these properties to provide for adequate protection of public health while allowing further use of land and other resources.

This engineering evaluation report (EER) addresses one of these MED/AEC sites known as Site A/Plot M, located in Palos Park, Illinois. The EER describes in technical detail a number of options for remedial action that could be taken with respect to the contamination at Site A/Plot M and presents estimates of the costs associated with these options. A companion document, "Environmental Analysis Report on a Formerly Utilized MED/AEC Site, Site A and Plot M, Palos Forest Preserve, Palos Park, Illinois" (ANL/ES-79), has also been prepared. It describes in detail the existing site environment and evaluates the environmental impacts of the various remedial options discussed in this report.

This EER contributes to a better understanding of the mitigation or resolution of environmental problems posed by the subject MED/AEC site and serves as a basis for determining whether or not remedial actions are warranted. The knowledge derived from the evaluation of a number of remedial options should be helpful in the final disposition of other MED/AEC sites located elsewhere.



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## 1. SUMMARY

This engineering evaluation report (EER) was prepared for the U.S. Department of Energy, Office of Remedial Action Programs, by the Engineering Division and the Division of Environmental Impact Studies, Argonne National Laboratory.

1. The subject of this EER is a formerly utilized MED/AEC site known as Site A/Plot M, located in the Palos Forest Preserve, Palos Park, Illinois. Site A refers to the 7.9-ha (19.5-acre) experimental area where the CP-2 and CP-3 reactors and associated buildings and laboratories were built and operated by the University of Chicago Metallurgical Laboratory and Argonne National Laboratory from 1943 to about 1956. Plot M refers to a 0.4-ha (1-acre) radioactive waste burial site 610 m (2000 ft) north of Site A.
2. The options for remedial action that are evaluated are:
  - a. Option I: No remedial action taken (status quo); radiological monitoring of the sites would continue.
  - b. Option II: Excavation and removal of buried materials at Site A and Plot M.
  - c. Option III: Waterproofing the concrete cover and installing drain tiles around Plot M to prevent surface waters from penetrating the cover and leaching the buried materials into the groundwater.
  - d. Option IV: Installation of a fully enclosed well bore through contaminated perched water to provide water with much lower tritium content than water from existing wells.
  - e. Option V: Installation of a cover with drain tile over the buried material at Site A to prevent surface waters from reaching the buried material.
  - f. Option VI: Installation of a barrier wall around the buried wastes to minimize contact with groundwater.
  - g. Option VII: Closing the picnic wells to prevent the public from drinking the tritiated water.
  - h. Option VIII: Providing the public with a substitute source of water having a much lower tritium content.
3. The estimated total costs of implementing the various remedial actions are summarized below. The \$50,000 annual cost for the ongoing radiological monitoring program is listed under Option I but has not been included in the costs listed for the other options. Some modifications in the radiological monitoring program will be required if an option

other than Option I is implemented. However, the total annual cost of the monitoring program is estimated to remain at about \$50,000.

	<u>Cost (January 1, 1979 \$)</u>
Option I	50,000
Option II	
Plot M	5,937,000
Site A	<u>4,846,000</u>
Total	10,783,000
Option III	
Suboption 1: Lead liner	356,000
Suboption 2: Membrane	190,000
Suboption 3: Bentonite layer	82,000
Option IV	16,000
Option V	
Suboption 1: Lead liner	173,300
Suboption 2: Membrane	133,300
Suboption 3: Bentonite layer	28,300
Option VI	
Plot M	385,000
Site A	<u>434,000</u>
Total	819,000
Option VII (per well)	600
Option VIII	
Suboption 1: Water from new onsite well	3,500
Suboption 2: Water from offsite source	
Pump water from a remote location	57,000
Underground tank installation	18,000



## 2. SITE DESCRIPTION

In this section, a brief description of the site is provided as it relates to the engineering evaluation of the various options for remedial action. A much more detailed site description is presented in the companion document, "Environmental Analysis Report on a Formerly Utilized MED/AEC Site: Site A and Plot M, Palos Forest Preserve, Palos Park, Illinois."

### 2.1 LOCATION

Site A and Plot M are located in the Palos Forest Preserve (Red Gate Woods) about 32 km (20 miles) southwest of the center of Chicago and 30 m (18 miles) west of Lake Michigan (Fig. 2.1). Plot M is situated approximately 490 m (1600 ft) north of Site A in T37N, R12E, at approximately lat. 41°42' N. and long. 87°54' W.

### 2.2 PHYSIOGRAPHY

The sites are located on an isolated, wedge-shaped portion of glacial deposits typical of those occurring in northeastern Illinois and southern Wisconsin. The glacial deposits in this region exhibit rough knob and kettle topography. Erosional features include drainageways produced by glacial meltwaters, bluffs along shores, numerous small valleys, and ponds and marshes.

The isolated portion of glacial deposits is bordered on the north and west by the Illinois and Michigan Canal, the Chicago Sanitary and Ship Canal, and the Des Plaines River; on the south by the Calumet Sag Channel; and on the east by the low relief Chicago lake plain. Maximum topographic relief at the site is about 52 m (170 ft). Elevations vary from about 230 m (750 ft) just west of Site A to 213 m (700 ft) at Plot M to about 180 m (580 ft) at the two canals (Fig. 2.2).

### 2.3 LAND OWNERSHIP AND USE

Site A (approximately 7.7 ha [19 acres]) and Plot M (approximately 0.4 ha [1 acre]) are owned by the Cook County Forest Preserve District.<sup>1</sup> Currently, Site A and Plot M are surrounded by the Palos Forest Preserve, with the nearest developed recreational area being Red Gate Woods. Specifically, Site A and Plot M are not in a developed section of the woods, and, consequently, are not readily accessible to the public by vehicular transportation. The area, however, has many trails (used for hiking, cross-country skiing, and horseback riding) which give the public access to Site A/Plot M. Existing and future land-use plans indicate that no changes are anticipated in land use for the immediate future.<sup>1,2</sup>

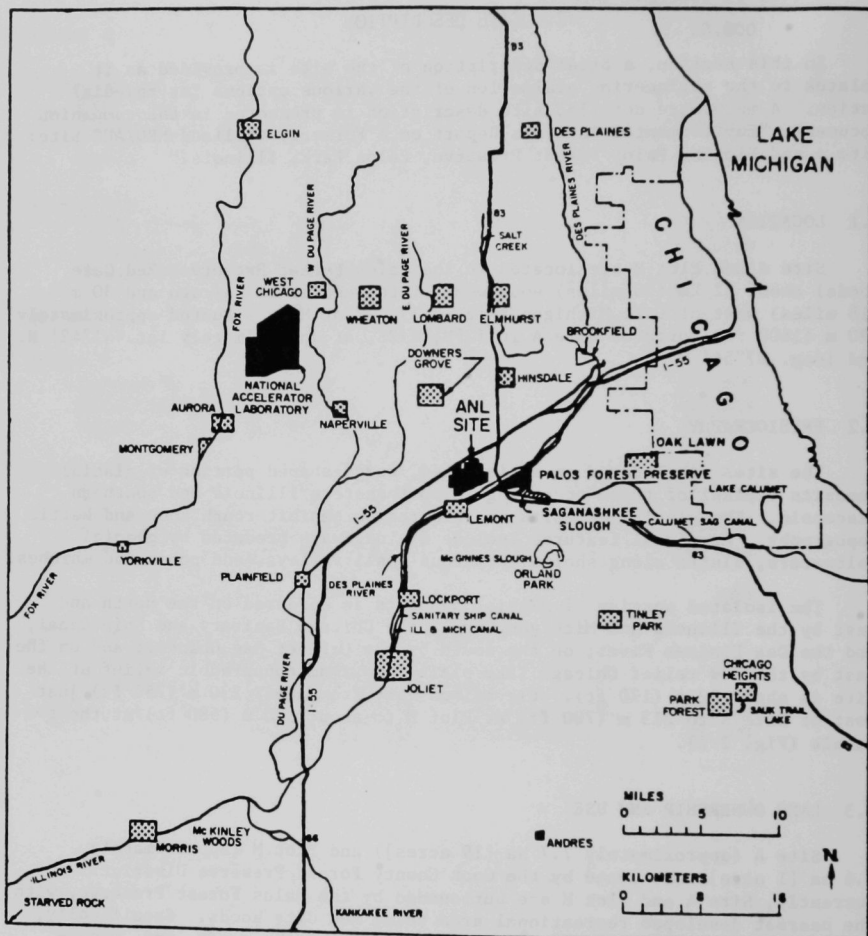
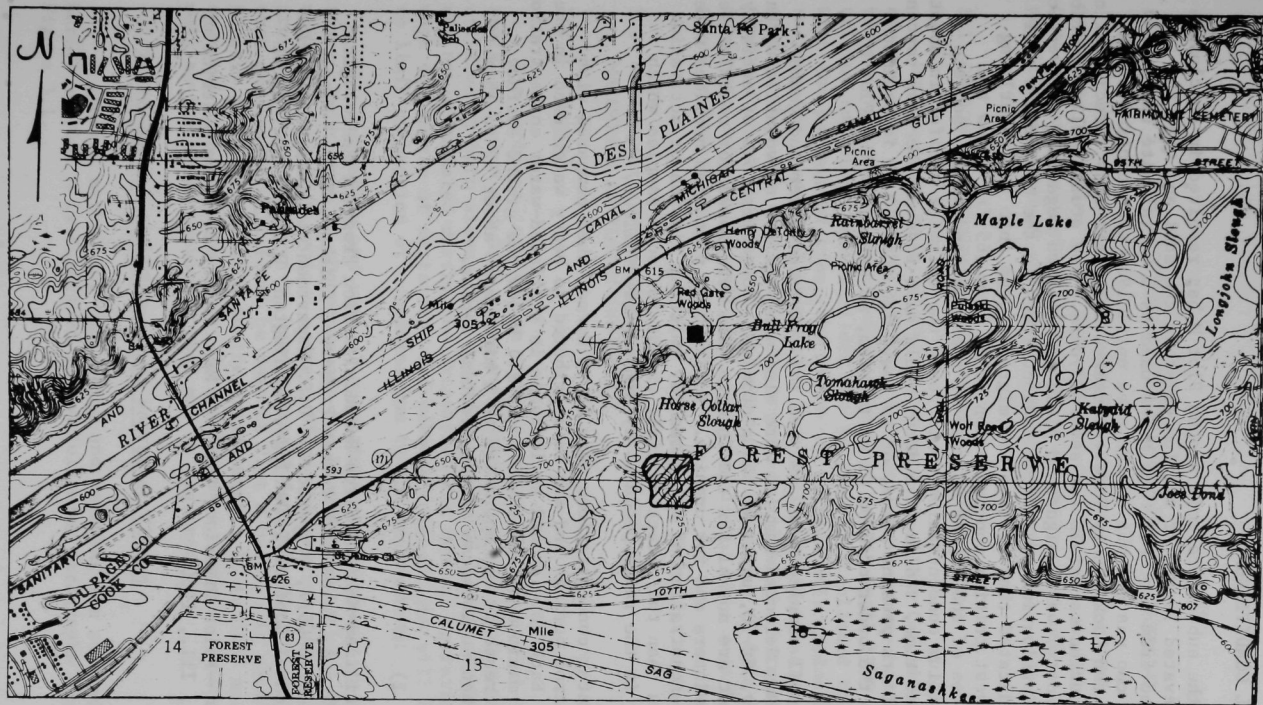




Fig. 2.1. Location of Palos Forest Preserve on Chicago Area Map.  
Source: Reference 1.



Site A   
 Plot M 

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET  
 1 5 0 1 KILOMETER  
 CONTOUR INTERVAL 5 FEET

Fig. 2.2. Topography of Site A/Plot M Area. Source: U.S. Geological Survey 7.5 minute series topographic map, "Sag Bridge" Quadrangle.

## 2.4 RADIOLOGICAL CONDITIONS

A study of the subsurface soil around Plot M has resulted in conclusive evidence that elevated levels of tritium exist in the soil and that the tritium originated from Plot M. Plot M was used as a burial site until 1949 and the concrete cap was not put on the area until 1956 when control of the site reverted to the Cook County Forest Preserve District; thus, precipitation infiltrated the buried materials for several years. The study (fully described in a 1978 DOE report<sup>1</sup>) was designed to yield information regarding the vertical and horizontal distribution of various radionuclides in the subsurface soil. Soil analyses indicated that tritium had migrated deep into the underlying subsoil, the highest tritium concentration being 20 m (65 ft) below the surface. Estimates of the migration rate of the tritiated water indicate that the peak tritium concentration would reach the dolomite aquifer in about 30 years. By that time, radioactive decay would have reduced the peak concentration to 19% of its present value, or to about 2.6 nCi/g. It is estimated that there is in the order of 3000 Ci of tritium, as water, in the Plot M area.

At Site A, soil samples were analyzed for tritiated water and gamma-emitting nuclides. Selected samples were also analyzed for nonvolatile alpha and beta activity, Sr-90, uranium, and plutonium. Concentrations of activity within ranges that are normal for the Chicago area were found for nonvolatile alpha and beta emitters and for uranium. No Sr-90 or plutonium nuclides were found, and the concentration of all gamma-ray emitting fission or activation products was less than the detection limit except for some samples which contained Cs-137 in the range produced by atmospheric fallout.

Tritiated-water concentrations were above normal when compared with samples from control borings and may be attributed to heavy water used in the CP-3' reactors. Each core showed an increase in tritiated-water concentration, with depth, to a maximum at about 4.5 m (15 ft) below the ground surface, followed by a decrease in concentration to a minimum at about 12 to 15 m (40 to 50 ft), and then an increase at the greatest depths.

## REFERENCES (Sec. 2)

1. "Formerly Utilized MED/AEC Sites Remedial Action Program; Radiological Survey of Site A, Palos Park Forest Preserve, Chicago, Ill.," Final Report, DOE/EV-0005/7, Prepared for U.S. Department of Energy, Division of Environmental Control Technology, Washington, D.C., 87 pp., April 1978.
2. Control Plan--Palos Division, Land Use Map, Forest Preserve District of Cook County, Ill., 1960.

### 3. DESCRIPTION OF POSSIBLE OPTIONS FOR REMEDIAL ACTION

In this section, several possible options for remedial action are described regarding the buried materials at Plot M and Site A. The related cost estimates are given in Section 4 of this report and are shown so as to permit extraction of the cost for various elements.

#### 3.1 OPTION I: STATUS QUO (NO REMEDIAL ACTION TAKEN)

One approach that will be considered is to let the sites remain as they are and take no remedial action. A radiological survey has been made of these two areas,<sup>1</sup> and the information presented in the April 1978 report shows that tritium and other radionuclides are all below established tolerance levels. With the passage of time, the amount of tritium will gradually decrease due to radioactive decay, and eventually this will completely alleviate the tritium concern that has been previously reported. Although no remedial action is proposed under this option, the radiological survey of Site A/Plot M and its immediate environment will continue. Details of this radiological survey are given in Reference 1.

#### 3.2 OPTION II: EXCAVATION AND REMOVAL OF BURIED MATERIALS AT PLOT M AND SITE A

##### 3.2.1 General

The problems involved in the excavation and removal of the buried materials at Plot M and Site A are very similar, and similar approaches could be utilized at both sites. The specific types and levels of contaminants that may be encountered during the excavation and removal operations are not known with any degree of certainty, and adequate precautions will have to be taken to limit dispersion of contamination to the environment.

The excavation and removal operations could proceed on one site at a time. Thus, some of the equipment can be utilized at both sites; this will minimize the total project costs. Since the tritium detected in the local groundwater is believed to have migrated from the Plot M site, it is assumed that excavation will first be done at Plot M because it poses a relatively greater potential problem to the environment. It is also assumed that prior approval from the Cook County Forest Preserve District will be obtained as well as any other approvals that may be required.

##### 3.2.2 Excavation and Disposal of Wastes at Plot M

A general method for excavating and removing the contaminated material buried at Plot M is described in the following paragraphs and illustrated in Figure 3.1.

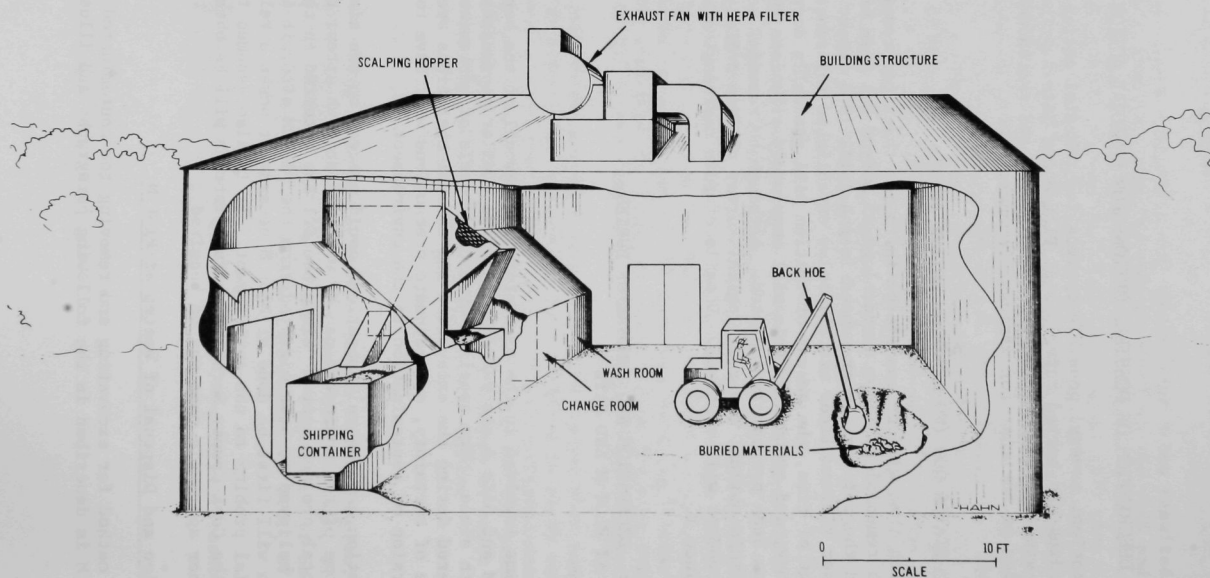


Fig. 3.1. Plot M Excavation Building.

All excavation will be done inside a 12 x 15 m (40 x 50 ft) containment building that will be erected. Principal equipment and facilities to be housed include a backhoe, a scalping hopper, bin loading areas, and wash and change rooms. The building will be supported on a pair of parallel beams which will span the excavation site. Concrete, earth, and buried materials will be removed by the backhoe and dumped into the hopper, where it will be delivered into storage bins; as the bins are filled, they will be removed by a forklift and replaced with empty bins. When the area within the building has been excavated to a depth of 2.4 m (8 ft) (maximum depth of buried materials) below the concrete cover, the building will be slid on the supporting beams to the adjacent area. A bulldozer will be used to move the building and doze fill material into the excavation.

Because of the topography of the Plot M site, it may be desirable to fence in a larger area than included in the estimate. Discussions will be held with the Cook County Forest Preserve District to verify the area that will be temporarily disrupted, the extent to which the existing topography may be altered, etc.

About 305 m (1000 ft) of roadway leading to the Plot M site will be improved. The improvement includes grading, scraping, and the addition of gravel as required. The design is based upon obtaining fill material from a local site to replace the excavated material from the Plot M site. Since only a nominal amount of fill material will be required, it is expected that obtaining the fill material will have a negligible impact on the environment.

An exhaust system with double high-efficiency-particulate air (HEPA) filters will be provided to keep the interior of the containment building at a negative pressure with respect to the atmosphere. This exhaust system will provide 10 air changes per hour. A standby fan unit will be provided. The excavating machine inside the building will be equipped with an enclosed operator's cab. The operator's cab will be supplied with filtered and heated or cooled air from the outside; no heat will be provided within the building. An electric hot water heater will be provided for the washroom. Electric heat and ventilation will be provided for the guardhouse, the change room, and the washroom. A 30.5-m (100-ft) deep well will be installed to provide water for washing, hosing down the excavated area to minimize dusting, decontamination of the interior of the building, etc. Bottled water from an offsite source will be used for the drinking water supply. Chemical toilets will be provided. An oil-free air compressor and air distribution piping are included for providing breathing air to personnel working inside the building. All personnel working within the building will wear protective clothing and face masks having an outside source of fresh air.

Two diesel electric generator units will be installed to provide electric power for the Plot M site. One unit will be capable of supplying all the required power; the second unit will be used as a standby. In selecting the power source for this site, consideration was given to extending a power line from the Commonwealth Edison lines along Archer Avenue. However, the cost for installing this line plus the cost for one diesel generator unit was approximately \$3,000 higher than the cost for installing two diesel generator units.



The general sequential steps for the excavation of the material at Plot M are as follows:

1. Preparation of the site including roadway repair; installation of security fencing, guardhouse, diesel generator units, and well; etc.
2. Removal of overburden down to concrete cover. The overburden will be stockpiled and used for site reclamation.
3. Installation of the beams which will be used to support and position the containment building.
4. Construction of the containment building with the building siding on the inside of the structural frame. The siding will be lined on the interior with a strippable coating to facilitate decontamination of the building.
5. Installation of the mechanical and electrical equipment in the building.
6. Breaking up (with jackhammers) the concrete cover that is inside the containment building and checking for contamination. If no contamination is found, the concrete will be removed to the outside of the building and saved for future use. If contamination is found, the concrete will be placed into bins for shipment to the disposal site. During steps 6 and 7, the material being removed will be kept moist to reduce airborne contamination.
7. Excavation of the dirt and debris to a depth of 2.4 m (8 ft) below the concrete cover. The excavated material will be placed in storage bins for shipment to the disposal site.
8. Sliding the building to an adjacent area when the excavation within the building has been completed, and repetition of the above process. As the building is moved, a bulldozer will doze fill material into the excavation.
9. Repetition of steps 6, 7, and 8 until all of the material at Plot M has been excavated, placed in shipping bins, and shipped to the disposal site.
10. Decontamination of the equipment used inside the containment building. This equipment will be saved for work at Site A. (The procedure described here is based on the assumption [as noted above] that Plot M presents a relatively greater potential problem to the environment, so that the remedial work should commence here rather than at Site A. If some of the equipment used at Plot M becomes contaminated to the extent that it cannot be used at Site A, then this equipment will be scrapped and new equipment purchased. The cost of the equipment would be a small percentage of the overall cost of the project.)



11. Decontamination and dismantling of the containment building. The building construction materials will be saved for future use at the ANL site or some other DOE installation.
12. Leveling the area after all equipment, fencing, guardhouse, etc., has been removed from the Plot M site. The area will be leveled using fill material, and then covered with topsoil and seeded.

### 3.2.3 Excavation and Disposal of Wastes at Site A

A general method for excavating and removing the material buried at Site A is described in the following paragraphs and illustrated in Figure 3.2. This phase of the work will be initiated after all work at Plot M has been completed.

A bulldozer will take off the top 1.2 m (4 ft) of earth fill and store it for use as future fill material. A 30.5 × 35 m (100 × 115 ft) metal containment building with an attached bin loading shed will be erected over the excavated area. All excavation, demolition, and bin filling will be done in this structure. Different-sized building structures have been selected for use at Plot M and Site A, based on such factors as differences in topography, depth of buried materials, and size of the area to be excavated. If a single structure--sized to span the entire area at Plot M--was selected, it would be larger than the one used at Site A and, hence, the cost would be considerably higher. Use of the smaller-sized building structure at Plot M will result in considerable savings in construction costs as well as operating costs. The material to be excavated at Plot M is only 2.4 to 3 m (8 to 10 ft) below the surface whereas the material at Site A is about 12 m (40 ft) below grade.

A backhoe will move the building rubble to a location under the clam-shell hoist; the clam shell will move the material to the scalping hopper where the fines will be loaded into one bin and the lump material into another bin. When the bins are filled, they will be removed for shipment to the disposal site. This procedure will be followed for all contaminated material. Should the building rubble be clean, it will be stored outside the containment building for use as future fill material.

The CP-2 rubble will be moved under the clam-shell hoist, and the clam shell will move the rubble to the bin loading area. If any large pieces are encountered, they will be reduced to shippable size by saws or air-ram breaking.

The reactor shield of CP-3 will be broken up by the following procedure. First, a series of 4.4-cm (1-3/4-inch) diameter holes will be drilled by jackhammers. These holes will go down about 5 m (16 ft) and be located on 0.6-m (2-ft) centers. Next, rock splitters will be inserted into the holes, and the side of the shield will be cracked open. The reinforcing steel will be cut with pneumatic saws, yielding slices of concrete which will be broken down to shippable sizes with an air ram. The backhoe will then move the concrete pieces to the clam-shell loading location, and the clam shell will place the concrete in the scalping hopper for loading into the bins.

The site will be enclosed by a 2.4-m (8-ft) high security fence. A heated and vented guardhouse will be provided. Approximately 150 m (500 ft)

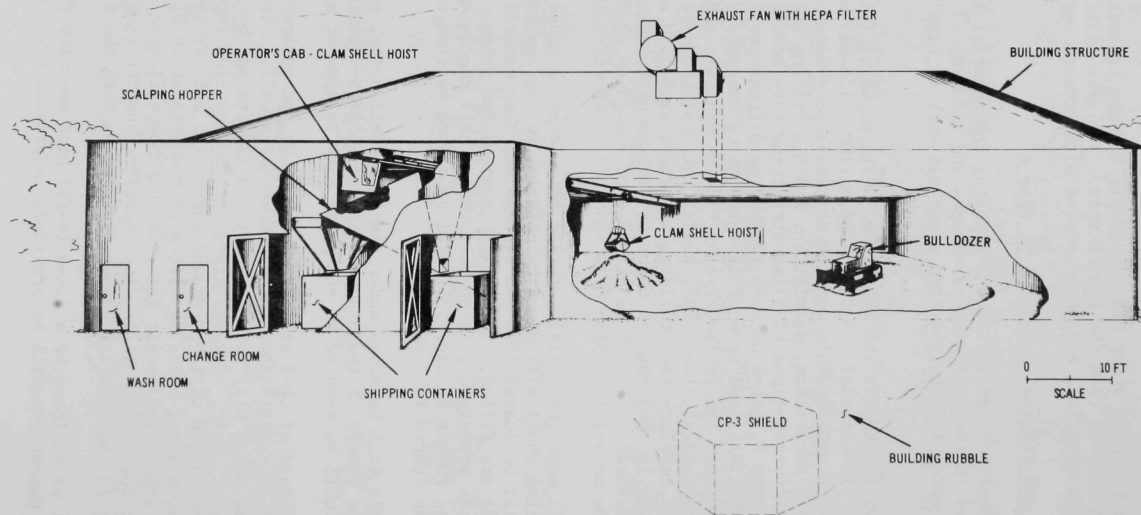


Fig. 3.2. Site A Excavation Building.

of roadway at Site A will have to be improved. The improvement includes grading, scraping, and the addition of gravel as required.

An exhaust system consisting of four modules will be provided to keep the interior of the containment building at a negative pressure with respect to the atmosphere. Each module will be a complete system with an air intake, prefilters, final HEPA filters, exhaust fan, and an air discharge stack through the roof. One module will be used as a standby unit. Each module will provide six air changes per hour when the HEPA filters are clean. When the filters become dirty and require changing, the module will provide approximately 2-3 air changes per hour.

The excavating machine and the clam shell inside the containment building will each be equipped with an enclosed operator's cab similar to that described in Section 3.2.2. Other supporting facilities provided for the excavation of Site A will be similar to those for Plot M--including electric heat and ventilation for the guardhouse, the change room, and the washroom; bottled drinking water; a deep well as a supplementary source of water; chemical toilets; provision for breathing air to personnel inside the building; two diesel-driven electric generators; and security lighting and alarms.

The general sequential steps for excavation of the material at Site A are as follows:

1. Preparation of the site including roadway repair; installation of security fence, guardhouse, diesel generator units, and well; etc.
2. Removal of overburden (1.2 m [4 ft] fill). The overburden will be saved for future use.
3. Construction of the containment building with the building siding on the inside of the structural frame. A strippable coating will be placed on the inside of the siding to facilitate future decontamination of the building.
4. Installation of building electrical and mechanical equipment.
5. Installation of excavating equipment inside the building.
6. Excavation of building rubble. If contamination is found, the material will be loaded into storage bins. If the material is clean, it will be stored outside for future reuse as fill. During steps 6 and 7, the material being removed will be kept moist to reduce airborne contamination.
7. Excavation of the CP-2 rubble in the same manner as the building rubble, down to the top of the CP-3' shield. At this time excavation will be halted, and the CP-3' shield will be drilled with holes for the rock-splitter operations. The rock splitter will be set to break side slabs off. Any reinforcement encountered will be sawed with pneumatic saws. The slabs will be broken down to shippable size and moved to the clam-shell handling area.

8. Further excavation around the CP-3' shield as required.
9. Repetition of the above procedures until all of the material at Site A has been excavated, placed in shipping bins, and shipped to the disposal site.
10. Decontamination of the containment building and equipment and removal of any remaining wastes. The containment building and equipment will be saved for use on other ANL or DOE projects.
11. Removal of the containment building, followed by replacement, tamping, and leveling of the backfill to natural grade. The area will be covered with topsoil and seeded.

### 3.2.4 Security

The excavation site will be completely surrounded with a chain link security fence about 2.4 m (8 ft) in height and topped with two strands of barbed wire. Perimeter lighting will also be provided. In addition, security personnel will be on duty 7 days per week, 24 hours per day. A guardhouse will be installed at the entrance to the fenced area.

### 3.2.5 Health Physics

The following are the general health-physics requirements during the removal work at Plot M and Site A.

Because much is unknown of the radioactive materials which have been buried at Plot M and Site A, complete containment as previously described will be provided during the excavation and removal operations. The filtered (high-efficiency) ventilation system will reduce the spread of contaminants to the environs. Appropriate utilities will be provided to the area including electric power, water, and breathing air. Electric power will be required for the operation of air samplers and other health-physics equipment. Water will be required for both emergency and nonemergency showering, for decontamination activities, and as a means to selectively wet down (dampen) the material being excavated to reduce the spread of contamination resulting from dusty conditions. Supplied breathing air and protective clothing will be required for all work performed within the containment structure. The containment structure will be designed and constructed to permit ease of decontamination, and adequate provisions will be made for the decontamination of all equipment used in the removal process. Suitable detection equipment, as well as radiation monitoring devices, will be provided to allow immediate assessment of air sample results and identification of contaminants found, as well as a record of the material being transferred for disposal.

### 3.2.6 Temporary Storage and Shipment of Contaminated Waste

Until recently, solid low specific activity (LSA) waste could be shipped to a licensed burial site at Sheffield, Illinois. However, the state of Illinois recently banned all radioactive waste disposal within the state. As defined in the Department of Transportation (DOT) regulations regarding radioactive materials, the containers used for shipping LSA waste must contain no

more than certain small, specified amounts of any isotope and less than 10 nCi of transuranics per gram. In the event any materials are uncovered at either Site A or Plot M which exceed the radioactivity limits for LSA waste, this material will be placed in bins and temporarily stored nearby at Argonne National Laboratory until such time as arrangements are made for its disposal. It is believed that all the material to be excavated at these sites will fall within the radioactivity limits for LSA waste.

All contaminated material removed from Plot M and Site A will be placed in DOT-approved containers for shipment. Figure 3.3 shows the overall dimensions of these containers. The shipping containers may be temporarily stored at the ANL Waste Storage Facility 317 prior to their shipment to a designated disposal site.

### 3.2.7 Radiological Survey

The same radiological survey of Site A/Plot M and its environment cited in Option I will continue, with appropriate modifications, after Option II is implemented.

## 3.3 OPTION III: WATERPROOFING THE CONCRETE COVER AND INSTALLING DRAIN TILES AROUND PLOT M

### 3.3.1 Concrete Cover Waterproofing

Waterproofing the concrete cover at Plot M will prevent surface waters from penetrating the cover and leaching contaminants from the buried materials into the groundwater. Due to the downward pitch of the concrete cover of approximately 8 cm/m (1 inch/ft) from south to north, the amount of surface water penetrating the cover is probably very small. Most of the surface water will run off the cover before it has time to penetrate; however, some surface water can penetrate the cover through cracks and construction joints if they exist. In order to prevent that, several methods of waterproofing the cover are discussed in the following paragraphs.

One method is to utilize a lead liner over the cover. Lead liners of this type have had numerous industrial applications. Many architectural applications have used lead as liners for pools, fountains, planters, etc. The expected life of a lead liner properly installed and protected will be on the order of 100 years. The existing ground cover, including vegetation and soil, will be removed from the concrete cover and stockpiled for reuse. The concrete cover will be swept clean and any rough or uneven spots in the concrete leveled off. Six-pound lead sheet will be laid on the concrete cover with the edges overlapped, and the joints will be burned. At the edge of the concrete cover, the lead sheet will extend down approximately 15.2 cm (6 inches). The lead sheet will then be painted with an asphalt paint, and a 10.2- to 15.2-cm (4- to 6-inch) thick concrete slab will be placed on it, providing physical protection to the lead sheet. The asphalt paint and the concrete slab will help to isolate the lead liner from groundwater and should minimize any possible dissolution of lead into the groundwater. The ground cover previously removed will be replaced over the new concrete slab, and the area will be graded and seeded.

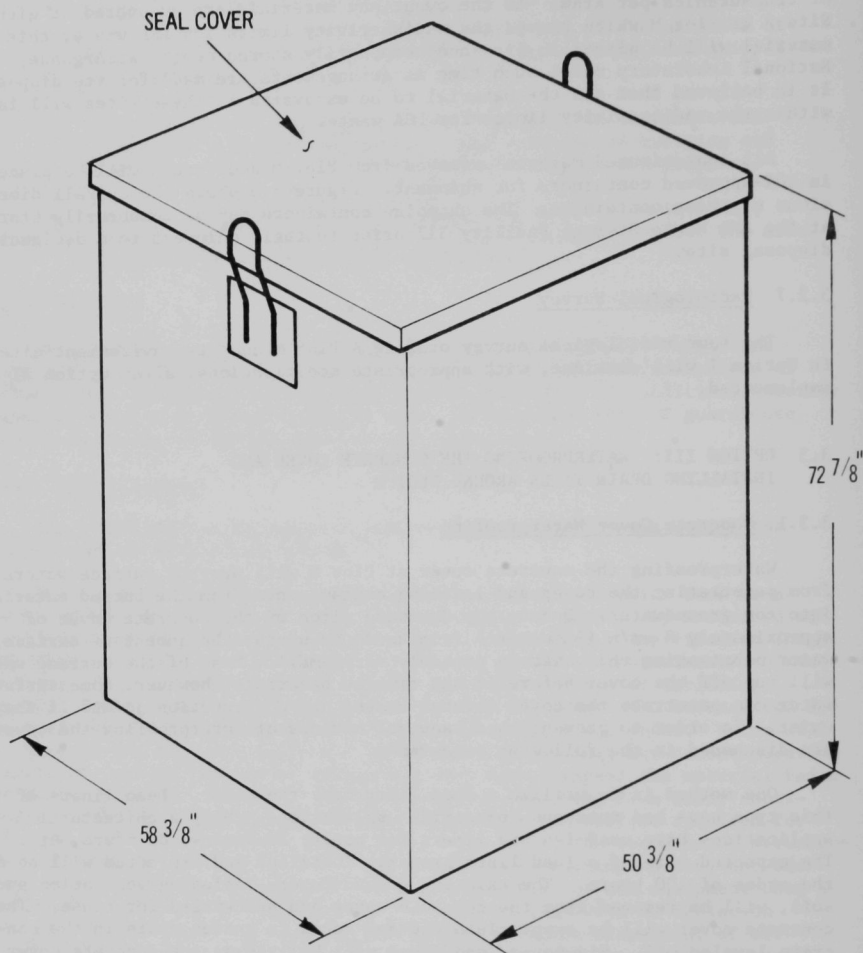


Fig. 3.3. DOT-Approved Shipping Container for Low Specific Activity Waste. Conversion factor: 1 inch = 2.54 cm.

Another method of waterproofing the concrete cover is to brush on a plastic membrane and cover this coating with a concrete slab. This method is used in construction work for the waterproofing of concrete slabs. Properly prepared and installed, this type of installation will have a useful life of at least 20 years, based upon similar applications. The ground cover will be removed and stockpiled for reuse. The concrete cover will be swept clean and the membrane (a polyurethane compound) brushed on to an approximate thickness of 0.15 cm (1/16 inch). After the membrane has cured, it will be covered with 0.3-cm (1/8-inch) thick cement-asbestos board; this board will provide physical protection to the membrane during subsequent operations. A 20.3-cm (8-inch) thick concrete slab will then be placed on the cement-asbestos boards, providing the additional protection that the membrane requires. The ground cover previously removed will be replaced over the new concrete slab, and the area will be graded and seeded.

A third method of sealing the concrete cover is to utilize a layer consisting of a mixture of bentonite and sand over the concrete cover. Bentonite is an absorptive clay that expands when exposed to water. Thus, in the proposed application, the bentonite will react with the surface water to form a waterproof layer. Bentonite liners have been used in industrial applications for sealing ponds and lagoons. The expected life of this type of installation will be at least 20 years. After the bentonite and sand layer has been installed over the concrete cover, it will be covered with an additional layer of sand to protect the bentonite-sand layer from subsequent grading operations. The ground cover previously removed will then be replaced, and the area graded and seeded.

Another method considered for waterproofing the concrete cover involves the use of a plastic liner such as Hypalon. Plastic liners have been used in industry for lining ponds and pits for the retention of water, and in this type of application, the liners will last at least 25 years. These plastic liners are subject to rodent damage and require appropriate protection. However, if a plastic liner is used to waterproof the concrete cover at Plot M, the plastic liner will require use of an additional concrete slab for protection against rodent damage. Because of this consideration, the plastic liner does not offer any advantages over the previously discussed methods of waterproofing the concrete cover. The estimated costs for using a plastic liner are comparable to the costs of the other methods which are given in Section 4.

### 3.3.2 Drain Tile Installation

During periods of heavy rain, there will be considerable surface water runoff from the covered area at Plot M. Drain tiles installed around the perimeter of the concrete foundation wall will prevent this surface water from reaching the groundwater in the immediate vicinity of Plot M. The drain tiles will be installed at a depth not to exceed the depth of the concrete foundation wall, which will provide the personnel installing the drain tile some degree of protection from radionuclides that may have been leached out of the buried materials. By installing the drain tile at the bottom of the concrete foundation, the drain tile will have a pitch of approximately 8 cm/m (1 inch/ft) from south to north; this pitch is more than adequate to provide proper drainage. A dry well will be installed approximately 15 m (50 ft) north of Plot M, and the perimeter drain tile will be connected to this well. In the drain



line to the dry well, a sampling station will be provided for the purpose of obtaining water samples of the drain water. Except for the sampling station, all portions of this installation will be well below grade and hence not subject to vandalism.

### 3.3.3 Radiological Monitoring

The same radiological survey of Site A/Plot M cited in Option I will continue after Option III is implemented.

### 3.4 OPTION IV: INSTALLATION OF A FULLY ENCLOSED WELL BORE THROUGH CONTAMINATED PERCHED WATER

For this option, an assumption is made that the wells will be located close to the areas where the Forest Preserve District now has provided public facilities. In addition, the tritium content of the water from the proposed wells is expected to be less than 0.2 nCi/L.

Considering a new well at Red Gate Woods as a typical case, examination of the data presented in Table 18 of Reference No. 1 shows that a well would have to be at least 18 m (60 ft) deep in order to obtain water with less than the maximum specified tritium content. A well this deep rules out the hand-pumped wells now in use because hand-pumped wells cannot be used where the well depth exceeds 6 m (20 ft). In order to provide a source of drinking water at this site, either a submersible pump or a jet pump will have to be installed. A jet pump will be used because of easier maintenance.

Using a deep well with a jet pump poses a problem since electric power is not available at most of the Forest Preserve District's picnic areas. Thus, in order to provide a source of electric power at Red Gate Woods, electric power lines will have to be extended underground a distance of approximately 460 m (1500 ft) from the closest source of power.

An underground vault will be constructed at the well site, and the jet pump and a water storage tank will be installed in the vault. The jet pump will supply water to the storage tank where it will be stored at atmospheric pressure. A float-level control system will be installed to maintain the proper water level in the tank. Water will be pumped from the storage tank by means of a hand-operated pump.

The same radiological survey of Site A/Plot M cited in Option I will continue after Option IV is implemented. In addition, water from the new well will be monitored.

### 3.5 OPTION V: INSTALLATION OF A COVER WITH DRAIN TILE OVER THE BURIED MATERIALS AT SITE A

#### 3.5.1 General

All material from the buildings and selected material from the reactors at Site A were buried in a hole approximately 24 m (80 ft) in diameter by 12 m



(40 ft) deep. There were no provisions made to prevent groundwater and surface water from reaching the buried materials. Thus, under present conditions, these materials are subject to a leaching action by these waters. In this section, several proposals will be discussed for preventing surface water from reaching the buried material. The installation of a cover by itself will not have too great an effect on the overall reduction of the leaching effects of water unless some type of a barrier wall is installed around the buried materials in conjunction with the cover. The installation of the barrier wall is discussed in Section 3.6.

### 3.5.2 Cover Over Buried Materials

A ground-level cover over the buried materials will reduce the amount of surface water percolating down to the buried material. A circular cover 26 m (85 ft) in diameter will be used for all cases. The type of covers proposed for use at Site A are the same as those proposed for use at Plot M. These include lead sheeting between two concrete slabs, a membrane between two concrete slabs, and a bentonite-sand layer. All of these covers will be installed at a depth below the existing surface grade so as to maintain this grade at the completion of the construction work. All of the covers will be pitched from the center to the outer edge so as to provide adequate drainage.

### 3.5.3 Drain Tile Installation

To improve the effectiveness of the cover in preventing surface water from reaching the buried materials, drain tile will be installed around the perimeter of the cover. The drain tile will be at or slightly below the elevation of the cover at its perimeter and will collect the surface water runoff from the cover. The drain tile will be extended to a dry well approximately 23 m (75 ft) south of Site A. A water sampling station will not be provided in this installation since one would not expect to find radionuclides in the surface water which has run off from the cover.

### 3.5.4 Radiological Monitoring

The same radiological survey of Site A/Plot M cited in Option I will continue after Option V is implemented.

## 3.6 OPTION VI: INSTALLATION OF A BARRIER WALL AROUND THE BURIED WASTES

### 3.6.1 Plot M

The existing foundation wall at Plot M does provide a partial barrier to groundwater; however, since tritium has been found in the groundwater in this area, the foundation wall is evidently not a very effective barrier. In order to provide a barrier which will prevent groundwater from reaching the buried material, it is proposed to install steel piling plus a bentonite-slurry wall around the outer perimeter of the foundation wall. The steel piling will be driven down to a depth of approximately 6 m (20 ft) below grade. In order to completely seal the joints in the steel piling, a bentonite-slurry wall will be installed inside of the steel piling. Based upon industrial experience with steel piling, this installation should have a life of at least 100 years.

The existing concrete cover will have to be extended to the barrier wall. A drain tile installation will also be provided to collect and remove surface water runoff from the cover.

### 3.6.2 Site A

The buried materials at Site A will be protected from the leaching action of groundwater by the installation of a barrier wall. This barrier wall will consist of steel piling driven in a circular pattern approximately 26 m (85 ft) in diameter and down approximately 14 m (45 ft) below the existing grade. The joints in the steel piling will be sealed by means of a bentonite-slurry wall which will be installed on the inside of the steel piling. One of the covers described in Section 3.5 will be installed in conjunction with this barrier wall in order to prevent surface water from reaching the buried material. A drain tile installation will also be provided to collect and remove surface water runoff from the cover.

### 3.6.3 Radiological Monitoring

The same radiological survey of Site A/Plot M cited in Option I will continue after Option VI is implemented.

## 3.7 OPTION VII: CLOSING THE PICNIC WELLS

Closing selected, existing wells--based upon the tritium levels--will result in some inconvenience to the users of the areas affected. Signs will be posted at the entrances to the picnic areas stating that there are no water wells in the area and that persons using the picnic area will have to provide their own water supplies. This situation will continue until such time as the tritium concentration falls below a specific level. The wells will be put out of service by removing the hand pumps and capping the pipes leading to the well points. These wells can be monitored by removing the cap, taking a water sample, and then replacing the cap. The same radiological survey of Site A/Plot M cited in Option I will continue after Option VII is implemented.

Since the tritium concentration is high in the winter (when public use is lowest) and low in the summer (when public use is highest), a modification of the above option is to take the wells out of service during the winter and place them back into service during the summer. To accomplish this option, the well point would not be removed; the hand pump would be removed and the pipe connected to the well point would be capped. When it is desired to put the pump back into service, the cap would be removed and the hand pump would be installed. An advantage of this option is that the well point is left in place, thus permitting water samples to be obtained whenever desired.

## 3.8 OPTION VIII: PROVIDING A SUBSTITUTE SOURCE OF WATER TO THE PUBLIC

### 3.8.1 Water from a New Onsite Well That is Not Contaminated with Tritium

A number of test, shallow-well points will be driven for the purpose of obtaining water samples for tritium-content analysis. If an acceptable well

location is found, a hand-operated pump will be installed at that location. If an acceptable shallow-well location cannot be found, deeper test wells will be driven to locate a source of water which is free of tritium. The installation and operation of deep wells will be as described in Section 3.4.

### 3.8.2 Water from an Offsite Source

If it is determined that an acceptable well location cannot be found, water will be supplied to this area by other means. Two methods of accomplishing this are discussed below.

The first method considered is to pump water from an area which is known to have water with very low or no tritium content. Since all wells in the vicinity of Site A and Plot M are equipped with hand-operated pumps, an electrically operated pump will have to be installed at the selected source to provide the necessary water pressure. Water from this well will be pumped to the point of use via an underground pipe, which will be installed below the frost line to prevent freezing. In addition to having water of acceptable quality, other factors that will be considered in the selection of a well location include the availability of electric power, the distance between the well location and the area to be served, and the terrain through which the water-supply pipe will be installed. At the point of use, the water-supply pipe will terminate in an underground vault containing a water storage tank where water will be stored at atmospheric pressure. A float-level control system will be installed to maintain the proper water level in the tank. Water will be pumped from the storage tank by means of a hand-operated pump.

Another method considered for an offsite water source involves installation of a several thousand gallon water tank below the frost line. This tank will be filled with water from a tanker truck. The water will be pumped from the storage tank by means of a hand-operated pump. Frequency of refilling will depend upon water consumption. Connections will be provided for draining and flushing the tank. By installing the tank below the frost line, the water will remain relatively cool in summer time, and the tank will be protected from vandalism.

### 3.8.3 Radiological Monitoring

The same radiological survey of Site A/Plot M cited in Option I will continue after Option VIII is implemented.

## REFERENCE (Sec. 3)

1. "Formerly Utilized MED/AEC Sites Remedial Action Program; Radiological Survey of Site A, Palos Park Forest Preserve, Chicago, Ill.," Final Report, DOE/EV-0005/7, Prepared for U.S. Department of Energy, Division of Environmental Control Technology, Washington, D.C., 87 pp., April 1978.



#### 4. COST ESTIMATES AND SCHEDULES FOR POSSIBLE OPTIONS FOR REMEDIAL ACTION

Possible options for remedial action which could be undertaken at Plot M and Site A were discussed in Section 3. The estimated costs and schedules to accomplish these actions are presented in this section; more detailed cost breakdowns are presented in the Appendix. In general, engineering charges range from 16% of construction costs for the larger jobs to 40% for the smaller jobs; a contingency of 30% was used for most jobs. Where reliable costs were available, a contingency of 20% was used; however, where there were many unknowns, as in the excavation process at Plot M and Site A, a contingency of 100% was used.\* All costs shown are current to January 1, 1979. The schedule time includes engineering, procurement, and construction. No allowance has been included for obtaining approval or concurrence from the Cook County Forest Preserve District and other agencies on the actions to be undertaken.

In addition to the tabulated costs, the annual cost related to the ongoing radiological monitoring of Site A/Plot M, currently estimated at \$50,000, has to be taken into account for the overall cost of each alternative.

##### 4.1 OPTION I: STATUS QUO (NO REMEDIAL ACTION TAKEN)

Since there will be no engineering or construction activities required for this option, the only associated cost is that related to the ongoing radiological monitoring of the Site A/Plot M environment, currently estimated at \$50,000 per year.

##### 4.2 OPTION II: EXCAVATION AND REMOVAL OF BURIED MATERIALS AT PLOT M AND SITE A

###### 4.2.1 Plot M

The following breakdown shows the major costs associated with the excavation and disposal of the buried material at Plot M. In this estimate, it is assumed that all of the buried material within the confines of the existing concrete foundation wall will be excavated and removed.

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\*Note: Since little is known regarding the buried materials at Plot M and Site A, a contingency of several hundred percent may be more appropriate than the 100% contingency used in the estimate. It is standard engineering practice to use contingency factors which reflect the confidence level in the estimate. Thus, the percent contingency used ranged from 100% down to 20%.

Site preparation	\$ 25,100
Equipment* and structures	433,700
Shipping containers	942,400
Shipping and disposal	2,548,000
Dismantling and site restoration	55,100
Health-physics personnel	60,000
Security personnel	300,000
Maintenance personnel	34,000
Labor-excavation activities	310,700
Engineering	54,000
Subtotal	\$4,763,000
Contingency	1,174,000
Total	\$5,937,000

A time period of approximately 18 months will be required from the start of Title I engineering through procurement, site preparation, construction, excavation, shipping, and site restoration. Seven months will be required for the excavation phase. Since the excavation work will be performed in an unheated building, this phase of the work should be scheduled to start in late spring, with completion in the fall.

#### 4.2.2 Site A

The following breakdown shows the major costs associated with the excavation and disposal of the buried materials at Site A. The estimate is based on the assumption that all of the buried building rubble requires disposal as contaminated material.

Site preparation	\$ 19,100
Equipment* and structures	949,800
Shipping containers	711,400
Shipping and disposal	1,282,300
Dismantling and site restoration	100,600
Health-physics personnel	120,000
Security personnel	333,300
Maintenance personnel	38,000
Labor-excavation activities	183,500
Engineering	79,000
Subtotal	\$3,817,000
Contingency	1,049,000
Total	\$4,866,000

A time period of approximately 20 months will be required from the start of Title I through procurement, site preparation, construction, excavation, shipping, and site restoration. Nine months will be required for the excavation phase. Since the excavation work will be performed in an unheated building, this phase of the work should be scheduled to start in early spring, with completion in the fall.

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\*Includes cost of health-physics equipment.

#### 4.3 OPTION III: WATERPROOFING THE CONCRETE COVER AND INSTALLING DRAIN TILE AT PLOT M

##### 4.3.1 Waterproofing the Concrete Cover

In Section 3.3.1, several methods for waterproofing the concrete cover were discussed. The costs for these methods are as follows:

Suboption 1:	<u>Lead Liner</u>	
	Engineering	\$ 35,700
	Construction	223,000
	Contingency	<u>77,300</u>
	Total	\$336,000
Suboption 2:	<u>Membrane</u>	
	Engineering	\$ 18,000
	Construction	113,000
	Contingency	<u>39,000</u>
	Total	\$170,000
Suboption 3:	<u>Bentonite Layer</u>	
	Engineering	\$ 8,000
	Construction	40,000
	Contingency	<u>14,000</u>
	Total	\$ 62,000

It will take approximately four to six months to accomplish this work. It is preferable to do this work in summer or fall when the rainfall is less than in spring.

##### 4.3.2 Drain Tile Installation

The installation of drain tile around the perimeter of Plot M was described in Section 3.3.2. The costs for this installation are as follows:

Engineering	\$ 3,600
Construction	11,800
Contingency	<u>4,600</u>
Total	\$ 20,000

If the drain tile is installed in conjunction with another phase--i.e., waterproofing the concrete cover--two to four weeks will be added to that construction period. However, if it is the only job to be done, then it will take approximately four months to accomplish the work.

#### 4.4 OPTION IV: INSTALLATION OF A FULLY ENCLOSED WELL BORE THROUGH CONTAMINATED PERCHED WATER

The installation of a new well at Red Gate Woods was described in Section 3.4. The costs for this installation are as follows:

Engineering	\$ 2,800
Construction	9,400
Contingency	<u>3,800</u>
Total	\$ 16,000

Approximately four months will be needed to complete this work, and it should be done when the ground is not frozen.

#### 4.5 OPTION V: INSTALLATION OF A COVER WITH DRAIN TILE OVER THE BURIED MATERIALS AT SITE A

##### 4.5.1 Cover

In Section 3.5, several types of covers are described for installation at Site A. The associated costs are as follows:

Suboption 1:	<u>Lead Liner</u>	
	Engineering	\$ 17,400
	Construction	109,000
	Contingency	<u>37,600</u>
	Total	\$164,000

Suboption 2:	<u>Membrane</u>	
	Engineering	\$ 13,100
	Construction	82,000
	Contingency	<u>28,900</u>
	Total	\$124,000

Suboption 3:	<u>Bentonite Layer</u>	
	Engineering	\$ 2,400
	Construction	12,200
	Contingency	<u>4,400</u>
	Total	\$ 19,000

The installation of the bentonite layer will take approximately two to three months, whereas the other two types of covers will require six to eight months for completion. It is desirable to complete the construction phase of this work prior to the onset of freezing weather.

##### 4.5.2 Drain Tile

The costs for drain tile may be added to the above cover costs. The drain tile installation at Site A was described in Section 3.5.2. The costs



for this installation are as follows:

Engineering	\$ 1,500
Construction	6,000
Contingency	<u>1,800</u>
Total	\$ 9,300

Drain tile installation at Site A will be done in conjunction with the installation of a cover. Installation of drain tile will add two to four weeks to the time required for the cover installation.

#### 4.6 OPTION VI: INSTALLATION OF A BARRIER WALL AROUND THE BURIED WASTES

##### 4.6.1 Plot M

Section 3.6.1 describes the installation of a barrier wall around the outside of the existing foundation wall at Plot M. The costs associated with this installation are as follows:

Engineering	\$ 40,800
Construction	255,200
Contingency	<u>89,000</u>
Total	\$385,000

The installation of the barrier wall will take approximately six months and will be completed prior to the winter season.

##### 4.6.2 Site A

Section 3.6.2 describes the installation of a barrier wall around the buried materials at Site A. The costs associated with this installation are as follows:

Engineering	\$ 46,000
Construction	288,000
Contingency	<u>100,000</u>
Total	\$434,000

The installation of the barrier wall will take approximately six months and will be completed prior to the start of the winter season.

#### 4.7 OPTION VII: CLOSING THE PICNIC WELLS

This option is discussed in Section 3.7. The cost of removing the hand pump in the winter and then reinstalling it in summer is approximately the same as the cost of closing one picnic well--\$600. The schedule for accomplishing this work is one to two months and the work could be done anytime during the year.

## 4.8 OPTION VIII: PROVIDING A SUBSTITUTE SOURCE OF WATER TO THE PUBLIC

4.8.1 Water from a New Onsite Well That is Not Contaminated with Tritium

Section 3.8.1 describes the installation of a new onsite well. The following cost estimate assumes that a tritium-free well location can be found and that a maximum of four test wells were drilled.

Engineering	\$ 600
Construction	2,100
Contingency	<u>800</u>
Total	\$ 3,500

The above work can be accomplished in two to three months, and the work can be done whenever the ground is not frozen.

4.8.2 Water from an Offsite Source

The following two methods of obtaining water from an offsite source were discussed in Section 3.8.2. The costs associated with these installations are as follows:

Pump Water from a Remote Location

Engineering	\$ 8,800
Construction	35,000
Contingency	<u>13,200</u>
Total	\$ 57,000

It will take approximately six to eight months to accomplish the above work, and it will be done during the summer and fall.

Underground Tank Installation

Engineering	\$ 3,900
Construction	9,700
Contingency	<u>4,400</u>
Total	\$ 18,000

It will take approximately four to six months to accomplish the above work, and it will be done during the summer and fall.

The above costs do not include the costs of a tanker truck as it was assumed that the Forest Preserve District could either provide this service using their own personnel and equipment or contract for this service.

APPENDIX. BREAKDOWN OF COST ESTIMATES FOR  
POSSIBLE OPTIONS FOR REMEDIAL ACTION  
AT SITE A AND PLOT M

A breakdown of construction, engineering, contingency, and other related cost estimates are presented in this appendix. The totals for some of the estimates have been rounded.



PART I. COST BREAKDOWN FOR OPTION I: STATUS QUO  
(NO REMEDIAL ACTION TAKEN)

There will be no engineering and construction activities for this option. The only cost is that of the ongoing radiological monitoring of the Site A/ Plot M environment--\$50,000/yr.



PART II. COST BREAKDOWN FOR OPTION II: EXCAVATION AND REMOVAL  
OF BURIED MATERIALS AT PLOT M AND SITE A

Item	Quantity	Unit	Description
1. Excavation	100.00	cubic yards	Excavation of buried materials
2. Removal	100.00	cubic yards	Removal of excavated materials
3. Hauling	100.00	cubic yards	Hauling of excavated materials
4. Disposal	100.00	cubic yards	Disposal of excavated materials
5. Backfill	100.00	cubic yards	Backfill of excavated area
6. Grading	100.00	cubic yards	Grading of excavated area
7. Sealing	100.00	cubic yards	Sealing of excavated area
8. Restoration	100.00	cubic yards	Restoration of excavated area
9. Final Inspection	100.00	cubic yards	Final inspection of excavated area
10. Total	1000.00	cubic yards	Total cost of excavation and removal

Table II-1. Health-Physics, Maintenance, and Security  
Cost Estimates for Option II

Description	Cost (\$)
<u>Health-Physics Personnel and Equipment</u>	
Site A: 3 man-years @ \$40,000	120,000
Plot M: 1.5 man-years @ \$40,000	60,000
Counting equipment (Site A and Plot M)	<u>25,000<sup>a</sup></u>
TOTAL	\$205,000
<u>Maintenance Personnel</u>	
Required maintenance to diesel generators, air compressors, exhaust fans, perimeter lighting, etc. @ 16 h/wk; \$27.30/h; 4-1/3 wk/mo	
	~\$1,900/mo
<u>Security Personnel</u>	
Maintaining a guard plus supervision of Plot M or Site A (not including cost of guardhouse) @ 24 h/d; \$22.90/h; 7 d/wk	
	\$16,667/mo <u>\$200,000/yr</u>

<sup>a</sup>The \$25,000 cost for counting equipment is included only in the Plot M estimate, since this equipment will be saved for use at Site A.

Table II-2. Summary of Project Cost  
Estimates for Option II  
at Plot M

Description	Cost (\$)
Civil/Structural	4,174,000
Mechanical	46,000
Electrical	95,000
Engineering	54,000
Health Physics	60,000
Security	300,000
Maintenance	34,000
Contingency	<u>1,174,000</u>
TOTAL	\$5,937,000



Table II-3. Civil/Structural Cost Estimates  
for Option II at Plot M

Description	Quantity	Cost (\$)
<u>Equipment and Structures</u>		
Drott backhoe	1 each	44,450
Scalping hopper	1 each	15,250
Bulldozers	2 each	63,500
Reclamation bins	3,100 each	942,400
Building 40 x 50 ft, and ground beams	1 lot	81,300
Forklift truck	1 each	40,600
Health-physics equipment		25,000
Weigh scales	2 each	2,500
Air compressor, jackhammer, and 200 ft hose	1 lot	8,900
Well, 120 ft deep	1 each	3,200
Road repair	1,000 linear ft	10,000
Fencing	840 linear ft	15,100
Guardhouse, 10 x 10 ft		8,000
Subtotal		\$1,260,200
<u>Miscellaneous</u>		
Dismantling building and equipment		38,100
Site restoration		17,000
Subtotal		\$55,100
<u>Labor-Operation</u>		
Dozing and dirt cover	1,670 yd <sup>3</sup>	1,300
Demolition of concrete cover	225,000 ft <sup>3</sup>	50,800
Removal of concrete cover	830 yd <sup>3</sup>	57,800
Removal of 8 ft deep dirt	6,670 yd <sup>3</sup>	24,300
Borrow and dozing fill	3,335 yd <sup>3</sup>	19,000
Bin handling and loading	7,750 h	157,500
Subtotal		\$310,700
<u>Shipping and Receiving</u>		
Hauling to dump	372,000 ft <sup>3</sup>	781,200
Handling at burial site	372,000 ft <sup>3</sup>	1,767,000
Subtotal		\$2,548,200
TOTAL		\$4,174,000

Table II-4. Mechanical Cost Estimates for Option II at Plot M

Description	Quantity	Cost (\$)
Exhaust fan @ 4000 cfm, 5-inch static pressure, 5 hp, with inlet vanes, Trane #19, "Q" fan	3 each	9,300
Prefilters and holding frame, 32 ft <sup>2</sup> , Farr 30/30 and HP-100	2 each	900
Final filters and holding frame, 32 ft <sup>2</sup> (HEPA)	2 each	3,000
Test HEPA filters and repair	2 each	400
Filter manometers	4 each	200
Sheet metal	3,260 lb	10,600
Makeup air trunk, 8-in. diam. x 200 ft	200 ft	1,000
Makeup air unit, with dampers and static pressure controls	1 each	7,500
Startup, test and balance	40 h	1,000
Makeup air fan, 100 cfm, louver and filter	1 each	500
Electric heating coil, 0.5 kW, with air switch and SCR (silicon controlled rectifier) control	1 each	400
Area unit heater, 3 kW-230 V, with thermostat	1 each	300
Water and waste tank, 275 gal	2 each	800
Electric water heater, 1.5 kW	1 each	200
Water piping, fittings, and valves, 1/2-inch	1 lot	600
Guardhouse baseboard heater, 1 kW	1 each	100
Guardhouse exhaust fan, 100 cfm	1 each	200
Subtotal		\$37,000
+ 25% contractor overhead and profit		9,000
TOTAL		\$46,000

Table II-5. Electrical Cost Estimates for Option II at Plot M

Description	Quantity	Cost (\$)
Emergency power diesel fuel engine-generator set rated 60 kV•A - 48 kW (with auto transfer switch)	2 each	38,000
Diesel fuel tank and mounting support	4 each	2,600
Service entrance and distribution panel board, with 225 A main circuit breaker and twenty 1-pole and eight 2-pole breakers	1 lot	1,300
Branch wiring, motors	6 each	1,400
Motor starter and control wiring	6 each	2,300
Lighting, interior, vapor tight	12 each	3,100
Lighting, emergency, standby	4 each	1,600
Lighting, exterior building	8 each	2,500
Lighting, fence perimeter	12 each	4,900
Miscellaneous power outlets	6 each	800
Guardhouse, heating and lighting	1 lot	1,300
Alarm system	1 lot	3,600
Communications system	1 lot	2,700
Lightning protection	1 lot	900
Emergency generator set and tank removals		2,100
Lighting removals, indoor, perimeter		700
Guardhouse heating and lighting removal		300
Alarm system removal		500
Lightning protection system removal		300
Motor wiring and controls removal		800
Grounding system removal		400
Panel board removal		700
Subtotal		\$72,800
+ 30% contractor overhead and profit		<u>21,840</u>
TOTAL		<u>\$95,000</u>

Table II-6. Engineering Cost Estimates  
for Option II at Plot M

Description	Cost (\$)
Title I (preliminary design)	12,700
Title II (final design)	28,300
Title III (construction)	<u>13,000</u>
TOTAL	\$54,000

Table II-7. Contingency Cost Estimates for Option II at Plot M

Description	Cost (\$)	Contingency	
		%	\$
<u>Equipment and Structures</u>			
Drott backhoe	44,450	20	8,900
Scalping hopper	15,250	30	4,600
Bulldozers	63,500	20	12,700
Reclamation bins	942,400	20	188,500
Building, 40 x 50 ft	81,300	30	24,400
Forklift truck	40,600	20	8,100
Health-physics equipment	25,000	30	7,500
Weigh scales	2,500	20	500
Air compressors, jackhammers	8,900	20	1,800
Well	3,200	30	2,100
Road repair	10,000	30	3,000
Fencing	15,100	30	4,500
Guardhouse	8,000	30	2,400
Subtotal			\$269,000
<u>Miscellaneous</u>			
Dismantling building and equipment	38,100	100	38,100
Site restoration	17,000	50	8,500
Subtotal			\$46,600
<u>Labor</u>			
Dozing	1,300	30	400
Demolition (concrete cover)	50,800	30	15,200
Removal (concrete cover)	57,800	30	17,300
Removal (dirt)	24,300	50	12,200
Borrow and dozing fill	19,000	50	9,500
Bin handling and loading	157,500	100	157,500
Subtotal			\$211,600
<u>Shipping and Receiving</u>			
Hauling to dump	781,200	20	156,200
Handling at burial site	1,767,000	20	353,400
Subtotal			\$509,600
Subtotal - Civil/Structural			\$1,036,800
<u>Other</u>			
Mechanical items	46,000	30	13,800
Electrical items	95,000	30	30,000
Health physics	60,000	20	12,000
Security	300,000	20	60,000
Maintenance	34,200	30	10,300
Engineering	54,000	20	10,800
Subtotal - Other			\$136,900
TOTAL			\$1,174,000

Table II-8. Summary of Project Cost  
Estimates for Option II  
at Site A

Description	Cost (\$)
Civil/Structural	2,965,000
Mechanical	146,000
Electrical	136,000
Engineering	79,000
Health Physics	120,000
Security	333,000
Maintenance	38,000
Contingency	<u>1,049,000</u>
TOTAL	<u>\$4,866,000</u>

Table II-9. Civil/Structural Cost Estimates for Option II at Site A

Description	Quantity	Cost (\$)
<u>Equipment and Structures</u>		
Drott backhoe	1 each	44,450
Scalping hopper	1 each	15,250
Forklift truck, 5-ton capacity	1 each	45,650
Bulldozer	1 each	31,750
Air hoe ram	1 each	8,900
Overhead (crane with clamshell bucket)	1 each	167,650
Pneumatic saw	2 each	1,000
Rock splitter	4 each	33,550
Jackhammer, compressor, 200-ft hose	3 each	23,600
Reclamation bins	2,340 each	711,400
Building, 100 x 115 x 20-ft eave	1 lot	222,250
Building, 10 x 45 x 20 ft	1 lot	11,450
Building foundation	330 yd <sup>3</sup>	42,000
Well, 120-ft deep	1 each	3,200
Fencing	680 linear ft	10,900
Road repair	500 linear ft	5,000
Guardhouse, 10 x 10 ft	1 each	8,000
Weigh scales	2 each	2,500
Subtotal		\$1,388,500
<u>Miscellaneous</u>		
Dismantling building and equipment		76,200
Site restoration		34,400
Subtotal		\$110,600
<u>Labor-Operation</u>		
Dozing 4-ft dirt cover	1,164 yd <sup>3</sup>	2,500
Excavation, Building rubble	3,154 yd <sup>3</sup>	5,000
Excavation, CP-2 rubble	1,959 yd <sup>3</sup>	3,000
Drill holes (172) in CP-3 shield	345 yd <sup>3</sup>	8,900
Excavation, CP-3 shield	414 yd <sup>3</sup>	1,000
Borrow	5,527 yd <sup>3</sup>	16,500
Rock splitting concrete and air ram demolition	300 yd <sup>3</sup>	12,700
Hauling borrow	3,000 yd <sup>3</sup>	4,000
Dozing backfill	5,800 yd <sup>3</sup>	11,100
Bin handling and loading	5,850 hr	118,800
Subtotal		\$183,500
<u>Shipping and Receiving</u>		
Hauling to burial site	187,200 ft <sup>3</sup>	393,120
Handling at burial site	187,200 ft <sup>3</sup>	889,200
Subtotal		\$1,282,320
TOTAL		\$2,965,000

Table II-10. Mechanical Cost Estimates for Option II at Site A

Description	Quantity	Cost (\$)
Exhaust fan @ 24,000 cfm, 5-inch static pressure, 30-hp, with inlet vanes, Trane 40-Q	4 each	18,100
Prefilters with holding frame, 2 x 2 ft, Farr 30/30 and HP-100	96 each	7,200
HEPA filters with holding frame, 2 x 2 ft, Farr	96 each	29,200
Test and repair HEPA filters	1 lot	1,000
Filter manometers	8 each	1,200
Test static controls	1 lot	8,300
Sheet metal	13,000 lb	42,300
Startup, test and balance	1 lot	2,100
Makeup air fan for cab ventilation, 100 cfm, louver and filter	1 each	500
Electric heating coil, 0.5 kW, with air switch and SCR control	1 lot	3,600
Flexible duct for elephant trunk, 8-inch round	200 ft	1,000
Change and washroom unit heater, 3 kW, with thermostat	2 each	500
Exhaust fan for change room	1 each	200
Water and waste tank, 275-gal capacity	2 each	800
Electric water heater, 1.5 kW	1 each	200
Water and waste piping, fittings, and valves	1 lot	600
Guardhouse baseboard electric heater, 1 kW	1 each	100
Guardhouse exhaust fan	1 each	200
Subtotal		\$117,100
+ 25% contractor overhead and profit		28,900
TOTAL		\$146,000



Table II-11. Electrical Cost Estimates for Option II at Site A

Description	Quantity	Cost (\$)
Power panel, 480-V	1 each	1,600
Dry-type transformer, 30-kV·A, 480-208 Y/120 V	1 each	1,000
Lighting panel, 120/208	1 each	800
Lighting, interior, vaportight	60 each	15,600
Lighting, emergency	20 each	8,100
Lighting, exterior building	12 each	3,700
Lighting, fence perimeter	24 each	9,400
Miscellaneous power outlets	12 each	1,600
Guardhouse, heating and lighting	1 lot	1,300
Conduit and wire	1 lot	4,600
Grounding system	1 lot	2,600
Miscellaneous hardware and fittings	1 lot	2,600
Motor starters, 30-hp	4 each	1,600
Disconnect switches, 30-hp	4 each	300
Motor wiring, 30-hp	1 lot	900
Miscellaneous motor wiring, power and controls	5 each	1,400
Unit heater wiring, 3-kW	2 each	200
Water heater wiring, 1.5-kW	1 each	100
Communication system	1 lot	2,700
Alarm system	1 lot	5,800
Lightning protection	1 lot	2,300
Crane wiring	1 lot	1,000
Pump wiring	1 lot	700
Diesel generator, 150-kW, 460-V, three-phase, with waterproof housing and all accessories	1 lot	21,200
Diesel generator, 12-kW, 120/240-V, two-phase, 3-W, with waterproof housing and all accessories	1 lot	4,600
Transformer and panel board removal	1 lot	700
Emergency generator set and tank removal	1 lot	1,300
Lighting removals, indoor, perimeter, exterior	1 lot	2,600
Guardhouse, heating and lighting removal	1 lot	300
Alarm system removal	1 lot	800
Lightning protection system removal	1 lot	700
Motor wiring and controls removal	1 lot	1,300
Grounding system removal	1 lot	800
Subtotal		\$104,200
+ 30% contractor overhead and profit		31,800
TOTAL		\$136,000

Table II-12. Engineering Cost Estimates  
for Option II at Site A

Description	Cost (\$)
Title I (preliminary design)	22,000
Title II (final design)	43,000
Title III (construction)	<u>14,000</u>
TOTAL	<u>\$79,000</u>

Table II-13. Contingency Cost Estimates  
for Option II at Site A

Description	Cost (\$)	Contingency	
		%	\$
<u>Equipment and Structures</u>			
Drott backhoe	44,450	20	8,900
Scalping hopper	15,250	30	4,700
Forklift truck	45,650	20	9,100
Bulldozer	31,750	20	6,400
Air ram hoe	8,900	30	2,700
Overhead clamshell	167,500	30	50,000
Pneumatic saw	1,000	30	300
Rock splitter	33,550	30	10,100
Jackhammers, compressors	23,600	20	4,700
Building	275,700	30	82,700
Guardhouse	8,000	30	2,400
Weigh scales	2,500	20	400
Subtotal			\$182,400
<u>Site Preparation</u>			
Well	3,200	30	1,000
Fencing	10,900	30	3,300
Road repair	5,000	30	1,500
Subtotal			\$5,800
<u>Bins</u>	711,400	20	\$142,300
<u>Shipping and Receiving</u>			
Hauling to burial site	393,120	20	78,600
Handling at burial site	889,200	20	177,800
Subtotal			\$256,400
<u>Miscellaneous</u>			
Dismantling building and equipment	76,200	100	76,200
Site restoration	34,400	50	17,200
Subtotal			\$93,400
<u>Labor</u>			
Dozing 4-ft dirt cover	2,500	50	1,300
Excavation of building rubble	5,000	100	5,000
Excavation of CP-2 rubble	3,000	100	3,000
Drill holes in CP-3 shield	8,900	100	8,900
Excavation of CP-3 shield	1,000	100	1,000
Borrow	16,500	50	8,300
Rock splitting and air ram	12,700	100	12,700
Hauling borrow	4,000	50	2,000
Dozing backfill	11,100	50	5,600
Bin handling and loading	118,800	100	118,800
Subtotal			\$166,600
Subtotal - Civil/Structural			\$847,000
<u>Other</u>			
Mechanical items	146,000	30	43,700
Electric items	136,000	30	40,700
Health physics	120,000	20	24,000
Security	333,300	20	66,600
Maintenance	38,000	30	11,300
Engineering	79,000	20	15,700
Subtotal - Other			\$202,000
TOTAL			\$1,049,000



PART III. COST BREAKDOWN FOR OPTION III: WATERPROOFING  
THE CONCRETE COVER AND INSTALLING DRAIN TILES  
AROUND PLOT M

Table III-1. Summary of Project Cost Estimates  
for Waterproofing the Concrete Cap at  
Plot M with a Lead Liner

Description	Cost (\$)
Construction	223,000
Engineering, 16% of construction	35,700
Contingency, 30% of construction and engineering	<u>77,300</u>
TOTAL	\$336,000

Table III-2. Construction Cost Estimates for Waterproofing  
the Concrete Cap at Plot M with a Lead Liner

Description	Quantity	Cost (\$)
Strip and stockpile existing cover	1,667 yd <sup>3</sup>	1,200
Brush all loose material from cap	22,500 ft <sup>2</sup>	1,125
Cover concrete cap with 30-lb felt	22,500 ft <sup>2</sup>	1,076
Cover concrete cap with 6-lb lead--all joints to be burned, lead to extend 6 inches down sides of wall	22,500 ft <sup>2</sup>	122,820
Cover lead with 4-inch thick concrete slab; wire mesh #8 x 8 - 6 x 6 inch	278 yd <sup>3</sup>	55,600
Replace the materials previously removed and stockpiled, and grade	1,667 yd <sup>3</sup>	1,717
Add 4 inches topsoil, 5-mile haul	370 yd <sup>3</sup>	2,368
Reseed the area	30,000 ft <sup>2</sup>	2,500
Dozer, 270-hp, mobilization and demobilization		400
Dozer rental	4 days	2,400
Dozer operator	4 days	640
Paint lead with asphalt paint (paint \$5.00/gal, 200 ft <sup>2</sup> /gal coverage)	22,500 ft <sup>2</sup>	<u>2,138</u>
Subtotal		\$194,000
+ 15% contractor overhead and profit		<u>29,100</u>
TOTAL		\$223,000

Table III-3. Summary of Project Cost Estimates  
for Waterproofing the Concrete Cap at Plot M  
with a Plastic Membrane

Description	Cost (\$)
Construction	113,000
Engineering, 16% of construction	18,000
Contingency, 30% of construction and engineering	<u>39,000</u>
TOTAL	\$170,000

Table III-4. Construction Cost Estimates for Waterproofing  
the Concrete Cap at Plot M with a Plastic Membrane

Description	Quantity	Cost (\$)
Strip and stockpile existing cover	1,667 yd <sup>3</sup>	1,200
Brush and vacuum all loose material from cap	22,500 ft <sup>2</sup>	2,250
Apply membrane	22,500 ft <sup>2</sup>	24,750
Cover membrane with protective board, 1/8-inch Masonite	22,500 ft <sup>2</sup>	4,500
Pour 4-inch-thick concrete slab over membrane; wire mesh #8 x 8 - 6 x 6 inch	278 yd <sup>3</sup>	55,600
Replace the material previously removed and stockpiled, and grade	1,667 yd <sup>3</sup>	1,717
Reseed the area	30,000 ft <sup>2</sup>	2,500
Dozer, 270-hp, mobilization and demobilization		400
Dozer rental	4 days	2,400
Dozer operator	4 days	640
Add 4 inches topsoil, 5-mile haul	370 yd <sup>3</sup>	<u>2,368</u>
Subtotal		\$98,300
+ 15% contractor overhead and profit		<u>14,700</u>
TOTAL		\$113,000

Table III-5. Summary of Project Cost Estimates  
for Waterproofing the Concrete Cap at Plot M  
with a Bentonite-Sand Layer

Description	Cost (\$)
Construction	40,000
Engineering, 20% of construction	8,000
Contingency, 30% of construction and engineering	<u>14,000</u>
TOTAL	\$62,000

Table III-6. Construction Cost Estimates for Waterproofing  
the Concrete Cap at Plot M with a Bentonite-Sand Layer

Description	Quantity	Cost (\$)
Excavation	1,800 yd <sup>3</sup>	2,790
Bentonite cap	22,000 ft <sup>2</sup>	22,000
Sand backfill, 6 inches	415 yd <sup>3</sup>	4,150
Soil backfill, 2 feet	1,700 yd <sup>3</sup>	1,050
Mobilization and demobilization		400
Seeding	4 acres	3,610
Dozer		<u>800</u>
Subtotal		\$34,800
+ 15% contractor overhead and profit		<u>5,200</u>
TOTAL		\$40,000



Table III-7. Summary of Project Cost Estimates  
for Installation of Perimeter Drain Tile and  
Dry Well at Plot M

Description	Cost (\$)
Construction	11,800
Engineering, 30% of construction	3,600
Contingency, 30% of construction and engineering	<u>4,600</u>
TOTAL	\$20,000

Table III-8. Construction Cost Estimates for Installation of  
Perimeter Drain Tile and Dry Well at Plot M

Description	Quantity	Cost (\$)
Excavation	1,800 yd <sup>3</sup>	3,040
Vitreous clay tile, 6-inch diameter	610 linear ft	2,500
Gravel, 1-1/2 inches	68 yd <sup>3</sup>	1,190
Backfill	1,730 yd <sup>3</sup>	1,890
Sample station, concrete box	1 lot	320
Sample station, 8-inch diam. standpipe	10 linear ft	60
Dry well, 6-inch concrete pipe	6 linear ft	650
Dry well, 5-inch access cover	1 each	220
Gravel, 3 inches	10 yd <sup>3</sup>	170
Mobilization and demobilization		<u>220</u>
Subtotal		\$10,300
+ 15% contractor overhead and profit		<u>1,500</u>
TOTAL		\$11,800



PART IV. COST BREAKDOWN FOR OPTION IV: INSTALLATION OF A FULLY ENCLOSED WELL BORE THROUGH CONTAMINATED PERCHED WATER

Table IV-1. Summary of Project Cost Estimates for Option IV

Description	Cost (\$)
Construction	9,400
Engineering, 30% of construction	2,800
Contingency, 30% of construction and engineering	<u>3,800</u>
TOTAL	\$16,000

Table IV-2. Construction Cost Estimates for Option IV

Description	Quantity	Cost (\$)
Precast concrete manhole, 6-ft inside diameter x 8-ft deep	1 each	1,175
Precast slab top, 8-inches thick, 6-ft diameter	1 each	175
Well, 6-inch diameter, drill and cased, 100-ft deep	100 ft	840
Submersible pump, 4 ft, 1 hp (in manhole)	1 each	1,050
Steel expansion tank, 40 gal (in manhole)	1 each	115
Hand-operated pump	1 each	175
Miscellaneous piping, submersible pump to tank, tank to hand-operated pump	1 lot	200
Tank level control, Gems type (in manhole)	1 each	200
Wood pole, cross arms, insulators, and miscellaneous pole hardware		650
Cable trench, 1 x 3 ft, 6-inch diameter x 1500-ft long, plus 67% abnormal terrain factor	195 yd <sup>3</sup>	1,025
Cable, 2/C #6, direct burial cable	1,600 ft	1,856
Disconnect switch, pole mounted	1 each	175
Motor starter, disconnect switch (in manhole)		400
Transformer, single phase, 240-V, 1 kV·A	1 each	120
Wall-mounted incandescent fixture, exterior type, 100-W	1 each	27
Duplex receptacle plus box	1 each	<u>25</u>
Subtotal		\$8,200
+ 15% contractor overhead and profit		<u>1,230</u>
TOTAL		\$9,400

PART V. COST BREAKDOWN FOR OPTION V: INSTALLATION OF A COVER WITH DRAIN TILE OVER THE BURIED MATERIAL AT SITE A

Table V-1. Summary of Project Cost Estimates  
for Installing a Concrete Cover with a  
Lead Liner at Site A

Description	Cost (\$)
Construction	109,000
Engineering, 16% of construction	17,400
Contingency, 30% of construction and engineering	<u>37,600</u>
TOTAL	\$164,000

Table V-2. Construction Cost Estimates for Installing  
a Concrete Cover with a Lead Liner at Site A

Description	Quantity	Cost (\$)
Strip and stockpile cover, 100-ft diameter x 4-ft deep	1,164 yd <sup>3</sup>	838
Pour concrete cover, 85-ft diameter x 1-ft thick; wire mesh #8 x 8 - 6 x 6 inch	210 yd <sup>3</sup>	42,000
Cover concrete cap with 6-lb lead--all joints to be burned	5,675 ft <sup>2</sup>	31,200
Pour 4-inch-thick concrete slab; wire mesh #8 x 8 - 6 x 6 inch	70 yd <sup>3</sup>	14,000
Replace material previously removed and stockpiled, and grade	1,164 yd <sup>3</sup>	1,200
Add 4 inches topsoil; 5-mile haul	97 yd <sup>3</sup>	620
Reseed the area	7,850 ft <sup>2</sup>	650
Dozer, 270-hp, mobilization and demobilization		400
Dozer rental	4 days	2,400
Dozer operator	4 days	640
Cover concrete cap with 30-lb felt	5,675 ft <sup>2</sup>	270
Paint lead with asphalt paint	5,675 ft <sup>2</sup>	<u>540</u>
Subtotal		\$95,000
+ 15% contractor overhead and profit		<u>14,000</u>
TOTAL		\$109,000

Table V-3. Summary of Project Cost Estimates  
for Installing a Concrete Cover with a  
Membrane Liner at Site A

Description	Cost (\$)
Construction	82,000
Engineering, 16% of construction	13,100
Contingency, 30% of construction and engineering	<u>28,900</u>
TOTAL	\$124,000

Table V-4. Construction Cost Estimates for Installing  
a Concrete Cover with a Membrane Liner at Site A

Description	Quantity	Cost (\$)
Strip and stockpile existing cover, 100-ft diameter x 4-ft deep	1,164 yd <sup>3</sup>	838
Pour concrete cover, 85-ft diameter x 1-ft thick; wire mesh #8 x 8 - 6 x 6 inch	210 yd <sup>3</sup>	42,000
Brush and vacuum all loose material from cover	5,675 ft <sup>2</sup>	568
Apply membrane	5,675 ft <sup>2</sup>	6,270
Cover membrane with protective board, 1/8-inch Masonite	5,675 ft <sup>2</sup>	1,140
Pour 4-inch-thick concrete slab over protective board; wire mesh #8 x 8 - 6 x 6 inch	70 yd <sup>3</sup>	14,000
Replace material previously removed, and grade	1,164 yd <sup>3</sup>	1,200
Add 4-inches topsoil, 5-mile haul	97 yd <sup>3</sup>	620
Reseed the area	7,850 ft <sup>2</sup>	650
Dozer, 270-hp, mobilization and demobilization		400
Dozer rental	4 days	2,400
Dozer operator	4 days	<u>640</u>
Subtotal		\$71,000
+ 15% contractor overhead and profit		<u>11,000</u>
TOTAL		\$82,000

Table V-5. Summary of Project Cost Estimates  
for Installing a Concrete Cover with  
Bentonite-Sand Layer at Site A

Description	Cost (\$)
Construction	12,200
Engineering, 25% of construction	2,400
Contingency, 25% of construction and engineering	<u>4,400</u>
TOTAL	\$19,000

Table V-6. Construction Cost Estimates for  
Installing a Concrete Cover with  
Bentonite-Sand Layer at Site A

Description	Quantity	Cost (\$)
Excavation	840 yd <sup>3</sup>	1,300
Bentonite cap	6,500 ft <sup>2</sup>	6,500
Backfill, 6 inches sand	125 yd <sup>3</sup>	1,250
Backfill, 2 ft soil	500 yd <sup>3</sup>	300
Seeding	0.15 acre	130
Dozer		700
Mobilization and demobilization		<u>400</u>
Subtotal		10,580
+ 15% contractor overhead and profit		<u>1,590</u>
TOTAL		\$12,200



Table V-7. Summary of Project Cost Estimates  
for Installation of Drain Tile at Site A

Description	Cost (\$)
Construction	6,000
Engineering, 25% of construction	1,500
Contingency, 25% of construction and engineering	<u>1,800</u>
TOTAL	\$9,300

Table V-8. Construction Cost Estimates for Installation of  
Drain Tile at Site A

Description	Quantity	Cost (\$)
Dozer excavation	840 yd <sup>3</sup>	800
Vitreous clay drain tile, 6-inch diameter	330 linear ft	1,240
Gravel, 3 inches	40 yd <sup>3</sup>	400
Backfill	800 yd <sup>3</sup>	800
Grading	630 yd <sup>3</sup>	1,400
Seeding	0.15 acre	130
Mobilization and demobilization		<u>400</u>
Subtotal		5,170
+ 15% contractor overhead and profit		<u>780</u>
TOTAL		\$6,000



PART VI. COST BREAKDOWN FOR OPTION VI: INSTALLATION OF A BARRIER WALL  
AROUND THE BURIED WASTES

Table VI-1. Summary of Project Cost Estimates  
for Option VI at Plot M

Description	Cost (\$)
Construction	255,000
Engineering, 16% of construction	41,000
Contingency, 30% of construction and engineering	<u>89,000</u>
TOTAL	\$385,000

Table VI-2. Construction Cost Estimates  
for Option VI at Plot M

Description	Quantity	Cost (\$)
Sheet piling, 28 psf, 580 linear ft x 20-ft high	11,600 ft <sup>2</sup>	174,000
Slurry wall, 580 linear ft x 20-ft high (includes mobilization, placing, demobilization, and contractor overhead and profit)		<u>81,000</u>
TOTAL		\$255,000

Table VI-3. Summary of Project Cost Estimates  
for Option VI at Site A

Description	Cost (\$)
Construction	288,000
Engineering, 16% of construction	46,000
Contingency, 30% of construction and engineering	<u>100,000</u>
TOTAL	\$434,000

Table VI-4. Construction Cost Estimates for Option VI at Site A

Description	Quantity	Cost (\$)
Sheet piling, 267 x 45 ft	12,015 ft <sup>2</sup>	192,000
Slurry wall, 267 x 45 ft (includes mobilization, placing, demobilization, and contractor overhead and profit)	12,015 ft <sup>2</sup>	<u>96,000</u>
TOTAL		\$288,000



PART VII. COST BREAKDOWN FOR OPTION VII: CLOSING THE PICNIC WELLS

Table VII-1. Cost Estimates for Option VII

Description	Cost (\$)
Remove existing hand-operated pump	200
Prepare and post sign stating that drinking water is not available in the picnic area	100
Pull well point	<u>200</u>
Subtotal	\$500
Contingency, 20%	<u>100</u>
TOTAL	<u>\$600</u>



PART VIII. COST BREAKDOWN FOR OPTION VIII: PROVIDING A SUBSTITUTE SOURCE OF WATER TO THE PUBLIC

Cost (\$)	Description
100	Drill test well, No. 1
400	Install pump and electric motor
50	Test water sample for quality
150	Refrigerated box
100	Assess cost for pump, No. 1
11,500	Subtotal
115	+ 1% contractor overhead and profit
12,650	TOTAL

Table VIII-1. Summary of Project Cost Estimates  
for Providing a Substitute Source of Water from  
a New Onsite Well That is Not Contaminated  
with Tritium

Description	Cost (\$)
Construction	2,100
Engineering, 30% of construction	600
Contingency, 30% of construction and engineering	<u>800</u>
TOTAL	\$3,500

Table VIII-2. Construction Cost Estimates for Providing a Substitute  
Source of Water from a New Onsite Well That is Not Contaminated  
with Tritium

Description	Quantity	Cost (\$)
Drill test well, 20-ft deep	4 each	800
Install pump and obtain water sample	4 each	400
Test water sample for tritium		80
Hand-operated pump	1 each	360
Concrete pad for pump, 5 x 5 x 1 ft	1 yd <sup>3</sup>	<u>200</u>
Subtotal		\$1,840
+ 15% contractor overhead and profit		<u>275</u>
TOTAL		\$2,100

Table VIII-3. Summary of Project Cost Estimates  
for Providing a Substitute Source of Water  
by Pumping Water from an Alternate Source

Description	Cost (\$)
Construction	35,000
Engineering, 25% of construction	8,800
Contingency, 30% of construction and engineering	<u>13,200</u>
TOTAL	<u>\$57,000</u>

Table VIII-4. Construction Cost Estimates for Providing  
a Substitute Source of Water by Pumping Water  
from an Alternate Source

Description	Quantity	Cost (\$)
Precast concrete manhole, 6-ft inside diameter x 6-ft deep	2 each	1,460
Precast slab top, 8-inches thick x 6-ft diameter	2 each	350
Well, 6-inch diameter, drill and cased, 100-ft deep	100 ft	840
Submersible pump, 4-inch, 1-hp (in manhole #1)	1 each	1,050
Steel expansion tank, 40 gal (in manhole #2)	1 each	115
Hand-operated pump	1 each	360
Install 1-inch PVC schedule 80 pipe, ~100-ft lengths	2,500 ft	10,675
Clear and grub area for trenching	1 lot	1,000
Trench, 2500-ft long x 5-ft deep x 20-inches wide	772 yd <sup>3</sup>	5,515
Sand fill around pipe, 18-inches wide x 1-ft deep x 2500-ft long	154 yd <sup>3</sup>	1,386
Backfill trench	618 yd <sup>3</sup>	1,236
Rough grade trenched area, spread remaining 154 yd <sup>3</sup> of excavated material	1 lot	600
Connect 1-inch PVC pipe to pump and to tank	1 lot	200
Hydrotest PVC pipe joints	25 joints	1,000
Tank float level control	1 lot	150
Wood pole, cross arms, insulators, and miscellaneous pole hardware	1 each	615
Cable trench, 1-ft wide x 3-ft 6-inches deep x 1500-ft long	195 yd <sup>3</sup>	1,025
Cable, 2/C #6, direct burial cable	1,600 ft	1,856
Disconnect switch, pole mounted	1 each	175
Motor starter, disconnect switch (in manhole #1)	1 each	400
Transformer, one-phase, 240 V, 1 kV·A	1 each	120
Wall-mounted incandescent fixture, exterior type	1 each	27
Duplex receptacle plus box	1 each	25
Install steel ladder inside manhole, 6-ft long	2 each	400
Subtotal		\$30,600
+ 15% contractor overhead and profit		4,600
TOTAL		\$35,000

Table VIII-5. Summary of Project Cost Estimates  
for Providing a Substitute Source of Water  
by Installing an Underground Tank

Description	Cost (\$)
Construction	9,700
Engineering, 40% of construction	3,900
Contingency, 30% of construction and engineering	<u>4,400</u>
TOTAL	<u>\$18,000</u>

Table VIII-6. Construction Cost Estimates for Providing a Substitute  
Source of Water by Installing an Underground Tank

Description	Quantity	Cost (\$)
Steel tank, 2000-gal capacity, lithcote lining on interior, galvanic protection	1 lot	5,000
Truck-mounted crane, 12-ton (includes operator)	1 lot	440
Excavate for tank	71 yd <sup>3</sup>	700
Concrete pad for tank, 6 x 12 x 1 ft	3 yd <sup>3</sup>	600
Secure tank to concrete pad	1 lot	100
Install tank piping for fill, pump suction and vent	1 lot	500
Backfill around tank and spread remaining fill around area	1 lot	500
Install concrete pad for pump, 5 x 5 x 1 ft	1 yd <sup>3</sup>	200
Install hand-operated pump	1 lot	<u>360</u>
Subtotal		\$8,400
+ 15% contractor overhead and profit		<u>1,300</u>
TOTAL		<u>\$9,700</u>

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